

**PROPOSED SAMPLING RATIONALE  
SAINT LOUIS ORDNANCE PLANT  
AUGUST 2004**

**SURFACE SOIL**

Screening Criteria

Criteria used to screen surface soils represent potential pathways either for receptor direct exposure to contaminants or for migration of contaminants from one media to another where exposure may occur later. EPA Region 9 Preliminary Remediation Goals (PRGs) for soil in residential or industrial settings were used and assume exposure occurs primarily through incidental ingestion. EPA R9 PRGs for soil leaching to groundwater, also used, are set at levels below which migration is not likely to occur.

Figure 1 shows chemical analysis, detections, and concentrations exceeding one or more of the screening criteria. The following provides additional detail.

Chemical Analysis, Detections, and Exceedances

- VOCs were analyzed in 22 surface soil (0-1 ft bgs) samples and all results were nondetect.
- SVOCs were analyzed in 8 surface soil samples. Polycyclic aromatic hydrocarbons (PAHs) and phthalates were detected. Bis(2-ethylhexyl)phthalate was determined to be a lab contaminant based on the low, consistent concentrations found in most samples collected during the 1999 field investigation. PAHs were detected at concentrations exceeding screening criteria in 3 samples. However, detection limits in some samples were above screening criteria.
- Explosives were analyzed in 56 surface soil samples and all samples were nondetect.
- Polychlorinated biphenols (PCBs) were analyzed in one surface soil sample near a former transformer vault. Concentrations exceeded screening criteria. Although the transformer was subsequently removed, there is no documentation that contaminated soil was removed.
- Various metals were analyzed in 51 to 77 samples, depending on what analytical suite was requested (i.e., RCRA 8, TAL Metals, or Primary Pollutant List). Metals exceeding screening criteria in surface soil samples included: arsenic, antimony, lead, thallium, and zinc. (As, Sb, Pb, Tl, and Zn).

Potential Pathways of Concern

For surface soil, potential exposure by ingestion in either an industrial or a residential setting and subsequent risk is possible, based on the detected levels of As, Pb, Tl, benzo(a)pyrene, and benzo(b)fluoranthene. Screening results also indicated a potential leaching problem for Sb, As, and Zn. None of the organics detected in surface soil failed screening for leaching potential.

Proposed Sampling Locations

Fifteen (15) incremental composite soil samples are recommended for metals analysis (6010B/6020 TAL Metals). Locations are shown on Figure 1. Locations are proposed either near a previous location with some screening criteria exceedance or in an area that has not been previously sampled. Five samples will be collected from each location represented as a diamond on the figure. An equal volume from each of the five samples will be composited into one sample. An equal volume from that sample will then be composited with four samples from surrounding diamonds to develop an incremental composite sample for a given area. (For additional detail on incremental composite sampling refer to EPA 1992.)

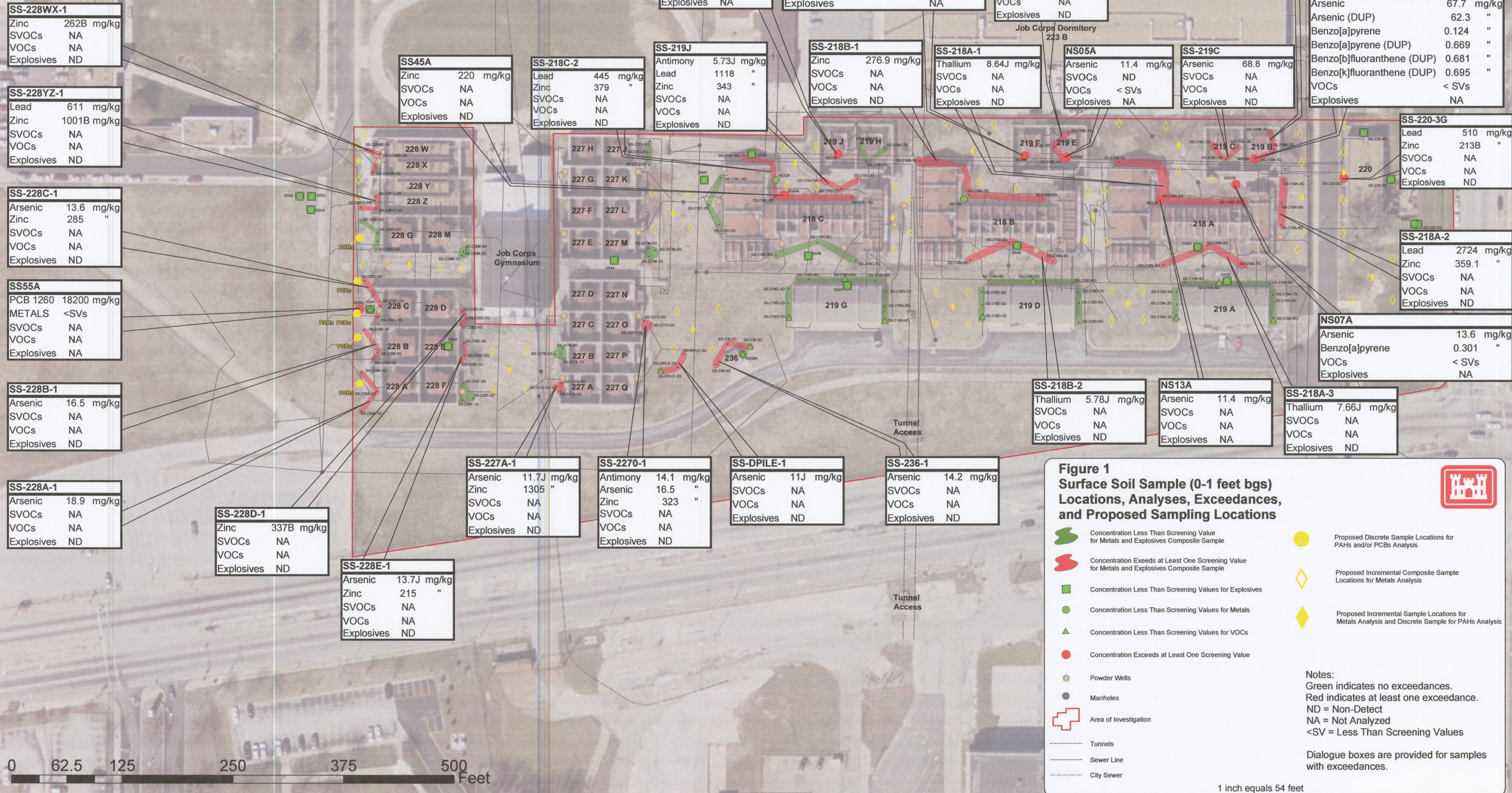
Eighteen discrete samples for PAH analysis (8270B-SIM) are proposed, with 15 from the center location for each of the incremental composite samples, and an additional 3 discrete samples collected to the west of the 228 series buildings. Previous sampling results in that area were nondetect; however, some detection limits exceeded screening criteria levels.

Three discrete samples for PCBs analysis (8280) are proposed in the location of the former transformer vault to confirm the presence or absence of contamination in the soil.

Previous sampling for explosives and VOCs provided adequate coverage in areas suspected of potential contamination. Since neither explosives nor VOCs were detected in any surface soil samples, none are proposed.



# Saint Louis Ordnance Plant





**PROPOSED SAMPLING RATIONALE  
SAINT LOUIS ORDNANCE PLANT  
AUGUST 2004**

**SUBSURFACE SOIL (1-2 FT BGS)**

Screening Criteria

Criteria used to screen soils represent potential pathways either for receptor direct exposure to contaminants or for migration of contaminants from one media to another where exposure may occur later. EPA Region 9 Preliminary Remediation Goals (PRGs) for soil in residential or industrial settings were used and assume exposure occurs primarily through incidental ingestion. EPA R9 PRGs for soil leaching to groundwater, also used, are set at levels below which migration is not likely to occur.

Figure 2 shows chemical analysis, detections, and concentrations exceeding one or more of the screening criteria. The following provides additional detail.

Chemical Analysis, Detections, and Exceedances

- VOCs were analyzed in 14 shallow subsurface soil (1-2 ft bgs) samples. Results were nondetect.
- SVOCs were analyzed in 14 surface soil samples. Several polycyclic aromatic hydrocarbons (PAHs) were detected. Benzo(a)pyrene and indeno(1,2,3-cd)pyrene were detected at concentrations exceeding industrial PRGs and benzo(a)pyrene also exceeded residential PRG. None of the PAHs exceeded available leaching potential PRGs. However, detection limits in some samples were above screening criteria.
- Explosives were analyzed in 13 samples and all results were nondetect.
- Polychlorinated biphenols (PCBs) were not analyzed in this medium.
- Various metals were analyzed in 22 samples (i.e., RCRA 8, TAL Metals, or Primary Pollutant List). Metals exceeding screening criteria in shallow soil included: arsenic and chromium, with maximum concentrations of 16.7 and 57.7 mg/kg, respectively.

Potential Pathways of Concern

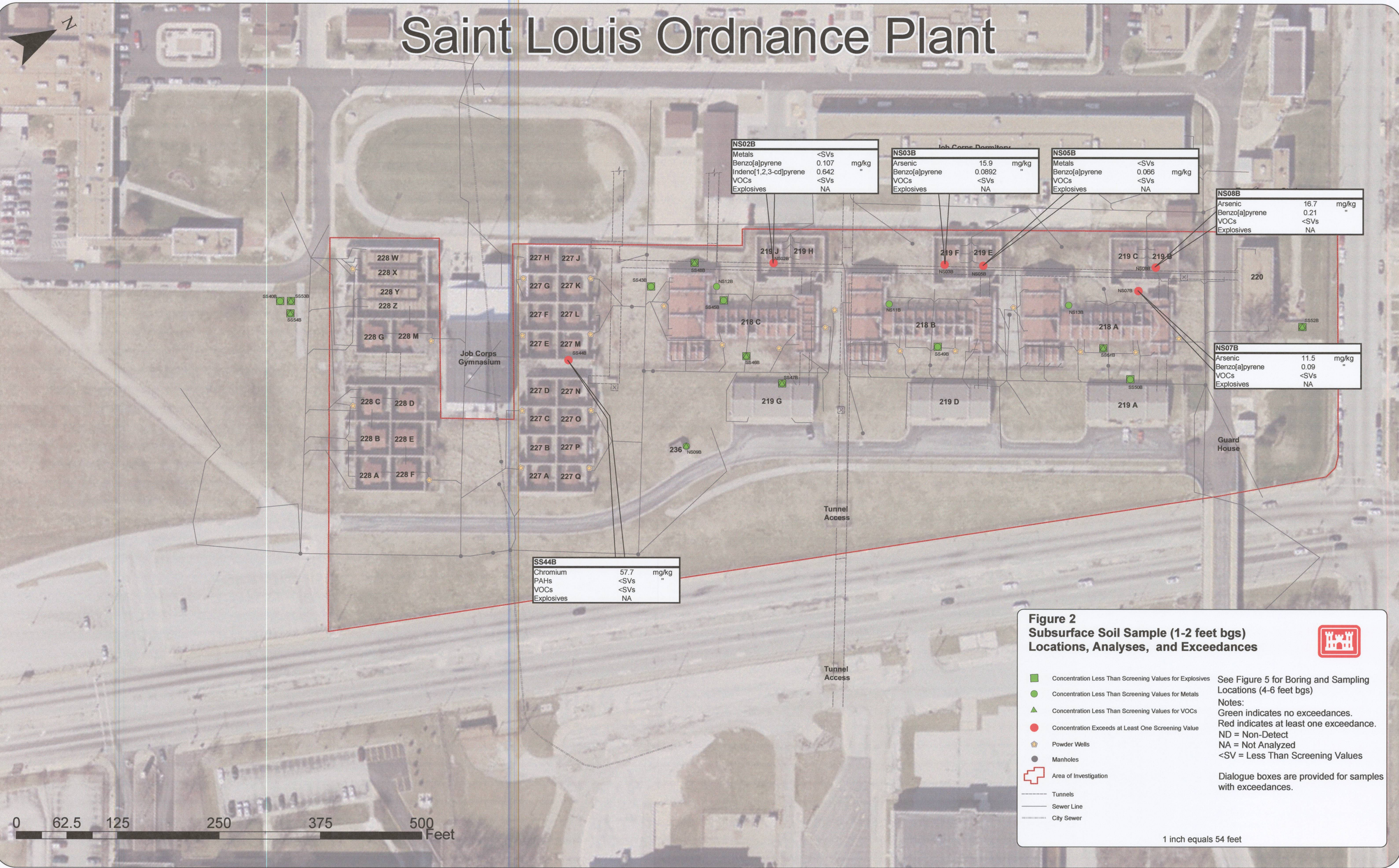
The likely exposure opportunity for shallow, subsurface soil is in a trenching scenario, such as a short-term installation or repair of a utility line. Residential and industrial PRGs, based on long-term exposures, likely overestimate the risk from exposure to this medium. However, based on screening results, arsenic may pose a potential risk in either an industrial or a residential setting. Note that the maximum level, however, appears to be at or near background. The screening result for chromium indicated a potential leaching problem. Benzo(a)pyrene and indeno(1,2,3-cd)pyrene may also pose risk from direct exposure in an industrial or residential setting. These were the only two organics exceeding screening criteria.

Proposed Sampling Locations

Sampling for shallow subsurface soil, i.e., soil in a typical trenching depth, will be collected from boring locations proposed on Figure 3. Twelve of the 20 borings will be sampled at 4-6 feet bgs to: 1) confirm the presence or absence of contamination; and 2) if contamination is confirmed, create a database for characterizing potential risk in the shallow soil where trenching for utilities may occur. These 12 samples will be analyzed for PAHs (8270B-SIM) and metals (6010B/6020 TAL). VOCs and explosives were not detected in surface or shallow subsurface soil in previous sampling events. While PCBs were detected in surface soil near the former transformer vault, migration potential for PCBs is very low and analysis is deemed unnecessary.



# Saint Louis Ordnance Plant



NS02B			
Metals	<SVs		
Benzo[a]pyrene	0.107	mg/kg	"
Indeno[1,2,3-cd]pyrene	0.642		
VOCs	<SVs		
Explosives	NA		

NS03B			
Arsenic	15.9	mg/kg	"
Benzo[a]pyrene	0.0892		
VOCs	<SVs		
Explosives	NA		

NS05B			
Metals	<SVs		
Benzo[a]pyrene	0.066	mg/kg	"
VOCs	<SVs		
Explosives	NA		

NS06B			
Arsenic	16.7	mg/kg	"
Benzo[a]pyrene	0.21		
VOCs	<SVs		
Explosives	NA		

NS07B			
Arsenic	11.5	mg/kg	"
Benzo[a]pyrene	0.09		
VOCs	<SVs		
Explosives	NA		

SS44B			
Chromium	57.7	mg/kg	"
PAHs	<SVs		
VOCs	<SVs		
Explosives	NA		

**Figure 2**  
**Subsurface Soil Sample (1-2 feet bgs)**  
**Locations, Analyses, and Exceedances**



- Concentration Less Than Screening Values for Explosives
- Concentration Less Than Screening Values for Metals
- ▲ Concentration Less Than Screening Values for VOCs
- Concentration Exceeds at Least One Screening Value
- ⬡ Powder Wells
- Manholes
- ⬢ Area of Investigation
- Tunnels
- Sewer Line
- City Sewer

See Figure 5 for Boring and Sampling Locations (4-6 feet bgs)

Notes:  
Green indicates no exceedances.  
Red indicates at least one exceedance.  
ND = Non-Detect  
NA = Not Analyzed  
<SV = Less Than Screening Values

Dialogue boxes are provided for samples with exceedances.

1 inch equals 54 feet



**PROPOSED SAMPLING RATIONALE  
SAINT LOUIS ORDNANCE PLANT  
AUGUST 2004**

**SUBSURFACE SOIL (> 4 FT BGS)**

Screening Criteria

Criteria used to screen soils collected at depth represent potential pathways for both direct receptor exposure to contaminants and for migration of contaminants from soil to groundwater, where exposure may occur later. EPA R9 PRGs for soil in residential or industrial settings assume exposure occurs primarily through incidental ingestion. EPA R9 PRGs for soil leaching to groundwater are set at levels below which migration is not likely to occur. For deep soils, the use of PRGs set for residential and industrial direct exposure is a conservative overestimate of potential risk since direct contact with soils at depth is unlikely to ever occur.

Figure 3 shows chemical analysis, detections, and concentrations exceeding one or more of the screening criteria for all samples collected at depth. Note that exceedances are for residential screening criteria and not the more relevant criteria for deep soils, which is the leaching potential pathway. None of the deep subsurface soil samples exceeded the leaching criteria. The following provides additional detail.

Chemical Analysis, Detections, and Exceedances

- VOCs were analyzed in 10 samples collected near the base of powder wells, near sewer lines, and around Monitoring Well MW01. Acetone was detected in 1 sample and methylene chloride was detected in 4; neither chemical exceeded its respective screening criteria. Naphthalene was detected in 1 sample, but did not exceed criteria.
- SVOCs were not analyzed in any of the samples collected at depth.
- Explosives were analyzed in 6 samples and all samples were nondetect.
- Polychlorinated biphenols (PCBs) were not analyzed in any of the soil samples collected at depth.
- Metals were analyzed in 7 samples. Metals exceeding screening criteria for residential exposure included arsenic and thallium (As and Tl) with the maximum concentrations of 15.8 and 5.2 mg/kg, respectively.

Potential Pathways of Concern

Deep soil samples, although not likely to ever be directly contacted by a receptor, did exceed residential PRGs set for arsenic and thallium. Levels of both metals are suspected to be within typical background ranges. None of the analytes failed screening criteria for the more relevant leaching migration pathway.

Proposed Boring Locations

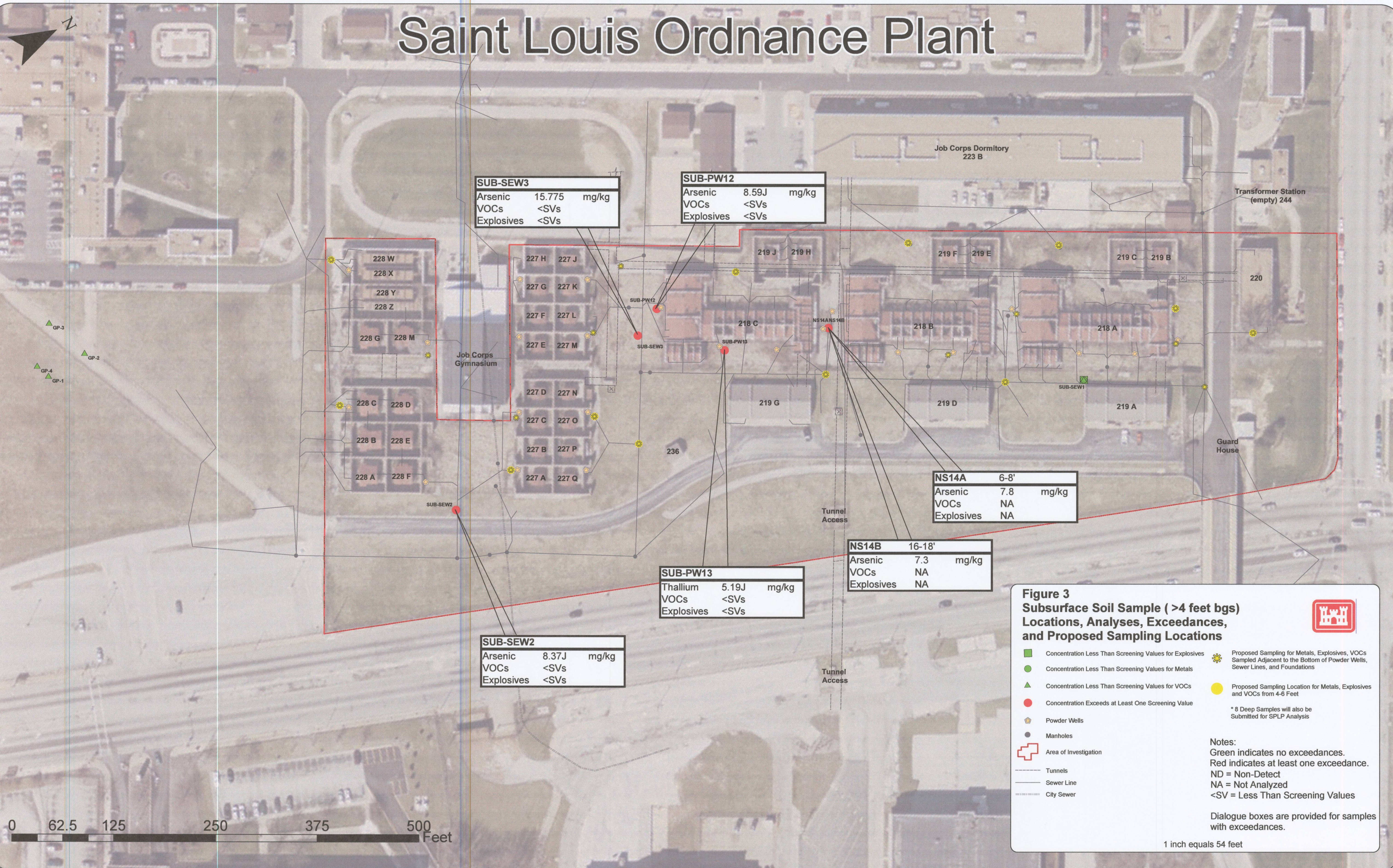
Twenty boring locations are proposed on Figure 3. The 20 borings will assess the potential of releases from leaking powder wells, potential leaks or breaks in sewer lines and potential contamination adjacent to basement foundations and tunnels. Twelve of the 20 locations will be sampled at 4-6 feet bgs to: 1) confirm the presence or absence of contamination; and 2) if contamination is confirmed, create a database for characterizing potential risk in the shallow soil where trenching for utilities may occur.

These 12 samples will be analyzed for PAHs (8270B-SIM) and metals (6010B/6020 TAL).

All 20 borings will be sampled for metals, explosives (8280) and VOCs (8260B). Nine of the 20 soil samples will be collected exterior and adjacent to the bottom of powder wells. These locations were selected either because of contamination detected in powder well sediment during a previous sampling event or the lack of sediment sampling data from a powder well. No exterior powder well will be sampled if previously sampled. Several of these 9 locations will also serve to assess the presence of contaminants near building foundations. Eight sampling locations are located at pipe tees, inlets or manholes where breaks or leaks in the sewers are more likely to occur. These 8 soil sampling locations were determined from historical drawings and depths will be crosschecked by determining actual pipe invert elevations in manholes prior to sampling. One soil sample will be collected from beneath an existing 1-ft diameter chipped hole through the floor in a utility tunnel. During a site visit in July 2004, the integrity of basement and tunnel floor and wall was very good aside from several transverse cracks in the tunnels. Most of the seepage appeared to be coming from the joints between the wall and floor slab or around holes in pipes passing through the foundation walls. Therefore, in lieu of drilling through the floor, samples will be collected on the exterior of the structures at the depth of the floor slab. One sample will be collected adjacent to a tunnel and one sample will be collected from adjacent to an exterior wall in Building 218 A. These locations were selected based on previous sediment sampling locations within the tunnels and buildings. The 3 samples collected from an elevation below the floor slabs, along with powder wells samples, will assess the presence of contamination around and below the foundations. In addition, 8 of 20 samples collected near potential sources will also be analyzed for SPLP for metals, explosives, and VOCs.



# Saint Louis Ordnance Plant





**PROPOSED SAMPLING RATIONALE  
SAINT LOUIS ORDNANCE PLANT  
AUGUST 2004**

**SEDIMENTS/SURFACE WATER**

Screening Criteria

Criteria used to screen sediments collected from tunnels, powder wells, and sewers represent pathways for both direct receptor exposure to contaminants and for migration of contaminants from soil to groundwater, where exposure may occur later. EPA R9 PRGs for soil in residential or industrial settings assume exposure occurs primarily through incidental ingestion. EPA R9 PRGs for soil leaching to groundwater are set at levels below which migration is not likely to occur. For tunnel sediments, which may still be accessed by trespassers, both types of criteria may be relevant. For sediments inside powder wells and sewers, where it is unlikely for direct contact to occur, leaching potential PRGs are more applicable. However, for a conservative, overestimate of potential exposure, all sediment data were screened for all pathways.

Criteria for screening surface water included maximum contaminant levels (MCLs) and EPA R9 PRGs for tap water. Both MCLs and PRGs for tap water are intended to be protective for potable water. Direct exposure to the surface waters through ingestion is unlikely to occur.

Figure 4 shows chemical analysis, detections, and concentrations exceeding one or more of the screening criteria for sediments and surface waters collected in tunnels, powder wells, and sewers. Detail follows:

Chemical Analysis, Detections, and Exceedances

- VOCs were analyzed in 3 sediment samples and results were nondetect.
- VOCs were analyzed in 4 water samples, with chloroform detected in 2 of those samples. Chloroform concentrations in surface water were below screening criteria.
- SVOCs were not analyzed in sediments or surface water samples.
- Explosives were analyzed in 28 sediment samples, with several explosives detected. Of those, 2,4-dinitrotoluene (DNT), 2,6-DNT, and nitrobenzene exceeded criteria for leaching potential. In addition, 2,4-DNT exceeded residential and industrial PRGs. All of the exceedances for explosives were found in sediments from powder wells. Except for one hit of 4-nitrotoluene in sewer sediment (218A), none of the explosives were detected in sewers or tunnels.
- Explosives were analyzed in 7 surface water samples and all results were nondetect.
- PCBs were not analyzed in any sediment or surface water samples.
- Various metals were analyzed in 37 sediment samples. Several metals exceeded residential and industrial PRGs; however, only those seen in tunnel sediments are representative of a potentially completed pathway. These metals include: antimony, arsenic, cadmium chromium, copper, iron, lead, manganese, thallium, and zinc. Barium also exceeded the residential PRG in powder well sediments, but does not represent a concern for direct contact. Metals exceeding screening criteria for leaching potential include: antimony, arsenic, chromium, and zinc in tunnel sediments; zinc in sewer sediments; and antimony, arsenic, chromium, and zinc in powder well sediments.
- Metals were analyzed in 8 surface water samples. Lead exceeded MCLs in three samples and thallium in one duplicate sample. Zinc exceeded PRGs for tap water in 4 samples.

Potential Pathways of Concern

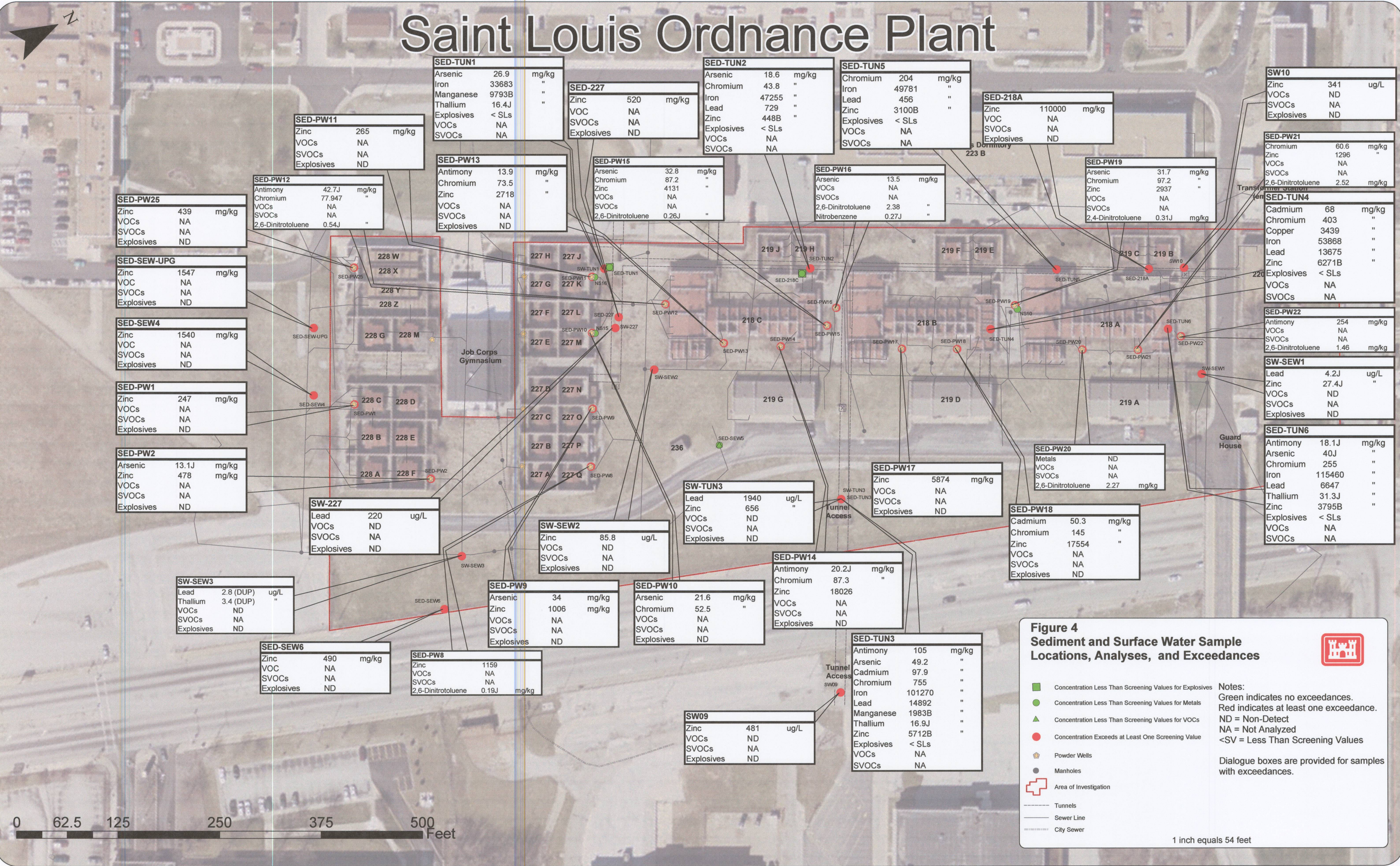
Direct contact to tunnel sediments might become a completed pathway, if trespassing occurs. However, existing sediment is currently being removed following the asbestos abatement of each building or tunnel. Asbestos abatement of all buildings and tunnels will be completed in the Fall of 2004. Leaching to groundwater and subsequent exposure to potable water is governed by the integrity of site foundations and powder wells. Based on a July 2004 inspection, the tunnels and basements are in very good condition with very few cracks. This pathway may become complete only if: 1) the integrity of tunnels, powder wells, or sewers are compromised; 2) leaching to groundwater occurs; and 3) migration to a potable well takes place. Similarly for surface water in tunnels, sewers, or powder wells, an exposure pathway may become complete if contamination first migrates to groundwater and then to a potable well.

Proposed Sampling Locations

No additional sediment or surface water sampling is proposed. All sediments will be removed from tunnels and buildings during ongoing asbestos abatement. The potential of contamination from the sediment to migrate into the groundwater is best assessed by evaluating contamination, if any, which has migrated from sources into subsurface soil over the past 60 years. Therefore, see Figure 3 for proposed boring locations.



# Saint Louis Ordnance Plant



**Figure 4**  
**Sediment and Surface Water Sample**  
**Locations, Analyses, and Exceedances**

Concentration Less Than Screening Values for Explosives  
 Concentration Less Than Screening Values for Metals  
 Concentration Less Than Screening Values for VOCs  
 Concentration Exceeds at Least One Screening Value  
 Powder Wells  
 Manholes  
 Area of Investigation  
 Tunnels  
 Sewer Line  
 City Sewer

**Notes:**  
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AUGUST 2004**

**GROUNDWATER**

Screening Criteria

Criteria for screening groundwater included maximum contaminant levels (MCLs) and EPA R9 PRGs for tap water. Both MCLs and PRGs for tap water are intended to be protective for potable water. Note that groundwater data are available from monitoring wells and direct push sampling. Note that metals data from direct push samples were not screened because of the potential influence of turbidity on concentrations.

Figure 5 shows chemical analysis, detections, and concentrations exceeding one or more of the screening criteria for groundwater samples taken from monitoring wells and direct push samples. Additional detail is provided below.

Chemical Analysis, Detections, and Exceedances

- VOCs were analyzed in samples collected from the 5 site monitoring wells and 16 direct pushes. Several VOCs were detected in the direct push samples surrounding MW101. Cis-1,2-dichloroethene and vinyl chloride concentrations in MW101 exceeded tap water PRGs. The concentration of cis-1,2-dichloroethene in MW101 also exceeded its MCL. Monitoring Well MW01 is considered upgradient of the site. Carbon tetrachloride was detected in MW105 at a level above the tap water PRG.
- SVOCs were not analyzed in samples collected from monitoring wells or direct pushes.
- Explosives were nondetect in the 5 monitoring wells sampled. 3-Nitrotoluene was detected in 2 of the 8 direct push groundwater samples analyzed for explosives, but concentrations were below the tap water PRG.
- PCBs were not analyzed in monitoring wells or direct push groundwater samples.
- Metals were not analyzed in samples taken from monitoring wells. Metals were analyzed in 12 of the direct push groundwater samples. Many exceeded MCLs and tap water PRGs; however, because of turbidity in the samples screening was deemed inappropriate.

Potential Pathways of Concern

An exposure pathway may become complete if contaminants detected in groundwater migrate to a potable well.

Proposed Sampling Locations

One monitoring well is proposed to assess groundwater quality hydraulically downgradient of Building 220 (Figure 5). The monitoring well will be installed at the bedrock and overburden interface consistent with the 5 existing monitoring wells. Upon completion of monitoring well installation and development, all 6 site monitoring wells will be sampled for VOCs, metals, and explosives.

SVOCs seen at the surface are believed not to be site related, but rather ubiquitous and due to anthropogenic sources, common in older metropolitan areas. While, soil samples at the surface are being collected for further assessment, none are proposed in groundwater because of their limited migration potential. Similarly, PCBs while detected near the former transformer vault, also are of low mobility and therefore not recommended for analysis.



# Saint Louis Ordnance Plant

